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in nutrient substrata of all sorts, might actually produce the smut diseases in the host plants; however convincing the experience of husbandmen on the relations of fresh dung to the appearance of smut diseases in grain,—the described results of artificial cultivation being also consonant—these alone do not amount to conclusive proof, but remain probabilities with which we can not be satisfied. *The new investigations of smut fungi, which began with the cultivation of the parasites outside of the host plants and which with the results here attained are half exhausted, will not be conclusive and exhaustive for the ætiology of smut diseases until the supplementary half is appended, until through various and rationally conducted infection experiments it is actually shown in what way and under what circumstances the richly multiplied germs living saprophytically outside of the host plants attack the latter and produce the smut diseases, how and in what places the germs penetrate into the host plants, and how within these, widely diverging from the transformations outside of the host plants, they are changed into smut spores.*

And now, for these infection experiments, the easy maintenance of smut fungi in any sort of nutrient solution and the subsequent endless increase of their germs, offered an inexhaustable source for the production, at will, of an infective material no less fresh and vigorous than capable of attack—a material, immediately and easily available in all possible variations, never before used, and admirably adapted for the artificial production of smut diseases in the host plants.

(To be continued.)

ON THE EFFECTS OF CERTAIN FUNGICIDES UPON THE VITALITY OF SEEDS.

A. A. CROZIER.

The influence of various chemicals upon the germination of seeds is but little understood. Many which have a fertilizing effect when applied in small amounts to the growing plant are injurious when a strong solution is applied to the seed. There is evidence, on the other hand, that many substances when applied to the seed will hasten germination and increase the vigor of the young plants. An account of some of these is given by Prof. L. H. Bailey, in Bulletin 31 of the Michigan Agricultural College.

The following experiments were made with blue vitriol and copperas at the Iowa Experiment Station in 1889:

First, a rough test was made with a strong solution of blue vitriol, a teaspoonful in half a saucer of water. Corn was soaked in this twenty-four hours, and another lot soaked in pure water the same length of time, and both lots planted in soil in the greenhouse May 11. Examination was made daily with the following results, the figures showing

the number of plants which had appeared above the soil on the given dates, 100 seeds of each having been planted :

I.—*Blue vitriol upon corn.*

Date.	Twenty-four hours.		Date.	Twenty-four hours.	
	Water.	Blue vitriol.		Water.	Blue vitriol.
May 16.....	57	5	May 24.....	98	85
17.....	96	45	25.....	98	86
18.....	97	52	26.....	98	86
19.....	97	56	27.....	98	86
20.....	98	71	28.....	98	87
21.....	98	77	29.....	98	87
22.....	98	79	30.....	99	87
23.....	98	80	31.....	99	89

The above table shows that the treatment with blue vitriol prevented the germination of some of the seeds and greatly retarded the germination of most of the others. Many of the plants from the seeds treated with the blue vitriol came up feeble, with leaves which appeared as though scorched. On June 7, a part of these plants had become healthy, but they were as a whole much smaller than those from the seed soaked in water only. The set treated with vitriol contained twenty-eight plants, which were notably weak, and the other set but three weak plants.

The next trial was with a solution of 10 gallons of water containing 5 pounds of blue vitriol (see Circular 5, of Sect. Veg. Path. U. S. Dept. Ag., p. 5). The seeds were placed in the solutions on May 28, and allowed to remain for three different periods before planting. Examinations were made at the dates indicated, the figures showing the number of plants which had appeared above the soil from time to time. One hundred seeds were planted in each case as before.

II.—*Blue vitriol upon corn.*

Date.	Ten minutes.		Five hours.		Twenty-four hours.	
	Water.	Blue vitriol.	Water.	Blue vitriol.	Water.	Blue vitriol.
June 5.....	10	5	0	0	2	0
6.....	57	41	20	7	40	20
7.....	81	63	75	41	77	60
8.....	91	85	91	72	87	75
9.....	95	87	93	85	89	79
10.....	95	89	93	87	91	88
11.....	95	92	93	91	93	93

Here a general retarding effect of the blue vitriol is visible, even when the application was made for the shortest time. The exceptions which appear are not sufficient to disturb the general result. There was also an enfeebling effect upon the young plants. On June 8 there were in the lot from seed which were soaked in water for ten minutes 6 feeble plants, and in that treated with vitriol for the same time, 23; in the lot treated with water five hours, 12; in that with vitriol, 19; in the lot treated with water twenty-four hours, 4; in that with vitriol, 22; making a total from 300 seeds soaked in water of 22 feeble plants, and from the same number soaked in blue vitriol, of 64.

The next table shows the results of the same solution upon wheat, the dates and conditions being the same as above.

III.—*Blue vitriol upon wheat.*

Date.	Ten minutes.		Five hours.		Twenty-four hours.	
	Water.	Blue vitriol.	Water.	Blue vitriol.	Water.	Blue vitriol.
June 5.....	77	46	60	23	45	2
6.....	81	55	77	40	82	10
7.....	81	58	78	42	86	16
8.....	82	62	82	43	91	23
9.....	83	74	85	45	92	29
10.....	83	79	85	45	92	34
11.....	85	80	85	48	93	37

It will be noticed from the above table that the wheat germinated much more quickly than the corn, and that the injurious effect of the blue vitriol was somewhat greater.

A more severe test was made with the same solution of blue vitriol (5 pounds to 10 gallons) upon the same sample of wheat by allowing about a pint of the seed to remain in the solution for thirty-nine hours, and the same amount in water for an equal length of time. At the end of that time the water was turned off, a part of the seeds of each lot kept damp by blotting paper, and the remainder planted. Nearly all the seeds which had been in water grew well, but none of those which had been in the solution of blue vitriol.

The next trial was of a solution of copperas or green vitriol upon corn. Copperas is used as a fertilizer, as a fungicide, and as an insecticide. Griffeth in his treatise on manures (London, 1889) after treating extensively of its use as a fertilizer, mentions its value as a fungicide, and states (page 302) that all fungous diseases of wheat may be destroyed by a top dressing of 50 pounds of copperas per acre, or by soaking the seed in a 1 per cent. solution.

In Bulletin 5 of the Iowa experiment station, on page 164, reference is made to the use of copperas as a remedy for cut-worms, the amount recommended being a little over 1 pound for a bushel of seed, with water sufficient to cover the grain.

This strength was taken for the trial, comparison being made with a much stronger solution, and also with pure water. The trial was made in duplicate, one set in the green-house, the other in the open ground, the other conditions being the same. The seed was soaked in each case twenty-four hours, and planted May 17, 100 kernels in a place as in the other tests. The examination was made daily, and, as in the other cases, as nearly as practicable at the same hour, usually at 6 a. m. The record begins on the day upon which the first plants appeared above ground.

IV.—*Copperas upon corn.*

Date.	(a) In the green-house.			(b) In the open ground.		
	Water.	Copperas, 1 pound per bushel.	Copperas very strong.	Water.	Copperas, 1 pound per bushel.	Copperas very strong.
May 24.....	51	35	16	12	1	1
May 25.....	84	70	45	45	32	20
May 26.....	91	79	68	68	65	59
May 27.....	94	86	72	80	76	73
May 28.....	94	87	80	82	80	74
May 29.....	94	88	85	83	81	79
May 30.....	94	93	86	84	86	79

A comparison of Tables IV with Tables I and II is sufficient to show that green vitriol (copperas) has nearly as injurious an effect upon the seed as blue vitriol. There was no scorching of the leaves noticeable, however, resulting from treatment with copperas, even with the strongest solution.

TREATMENT OF BLACK-ROT, BROWN-ROT, DOWNY MILDEW,
POWDERY MILDEW, AND ANTHRACNOSE OF THE GRAPE; PEAR
SCAB AND LEAF-BLIGHT, AND APPLE POWDERY MILDEW.

BY B. T. GALLOWAY.

BLACK-ROT.*

The experiments of the past two years have demonstrated beyond question the possibility of cheaply and effectively preventing this disease. Many things, however, in connection with its treatment remain to be discovered, so that rules now laid down will probably have to be modified, as future work gives us a better insight into the nature of the disease and the effects of different fungicides upon it. In the light of our present knowledge we would suggest the following lines of treatment, from which we will leave our readers to make their own selec-

**Laetstidia Bidwellii*, (Sacc.) V. R.